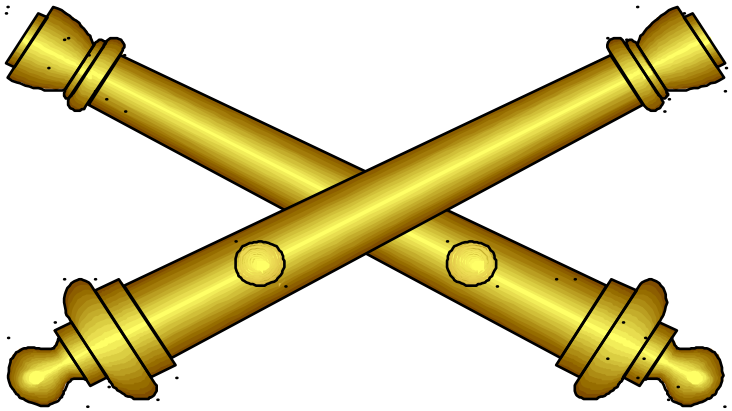
CRATER ANALYSIS & REPORTING



AGENDA

- PURPOSE
- REFERENCE
- WHAT IS CRATER ANALYSIS
- TEAM & EQUIPMENT
- DETERMINE DIRECTION
- SHELL REPORTS
- QUESTIONS

PURPOSE

To adequately support your maneuver unit, fire support personnel must know how to analyze and report crater information.

REFERENCES

FM 6-50 Appendix J

FM 3-100 STANAG 20

CRATER ANALYSIS

IS THE PROCESS BY WHICH THE DIRECTION TO AN ARTILLERY OR MORTAR UNIT IS DETERMINED FROM ANALYSIS OF THE SHELL CRATER. ADDITIONALLY, SHELL FRAGMENTS ARE COLLECTED TO DETERMINE THE TYPE OF SHELL THAT CAUSED THE CRATER.

CRATER ANALYSIS TEAM

- Greater reliance should be placed on reports from trained teams.
- All personnel should know how to analyze craters and submit the proper report.
- Each unit should select and train at least one team of two or three members.
- To support their maneuver unit, fire support personnel must know how to analyze and report crater information.

ELEMENTS

The three elements needed are; direction, dimension and curvature

They must all be measured for crater analysis to be successful.

EQUIPMENT

1. Declinated aiming circle or M2 compass
2. 4 stakes
3. Communications Wire (used to obtain the direction from the crater to or[illegible]e

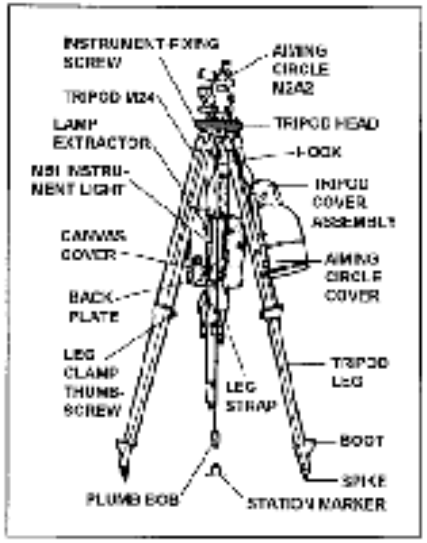


Figure 4-4. Aiming circle with tripod

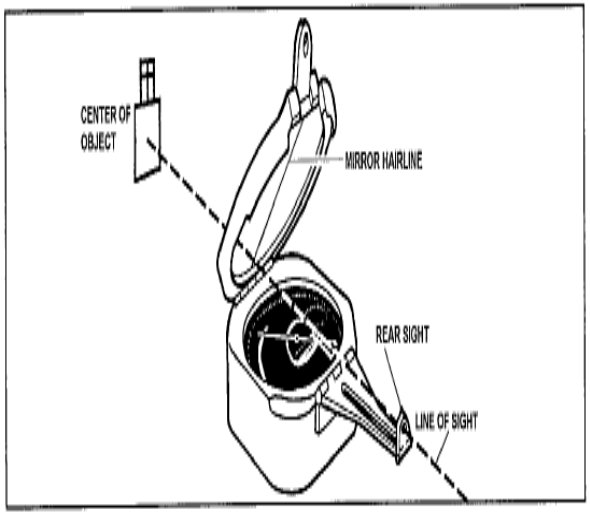
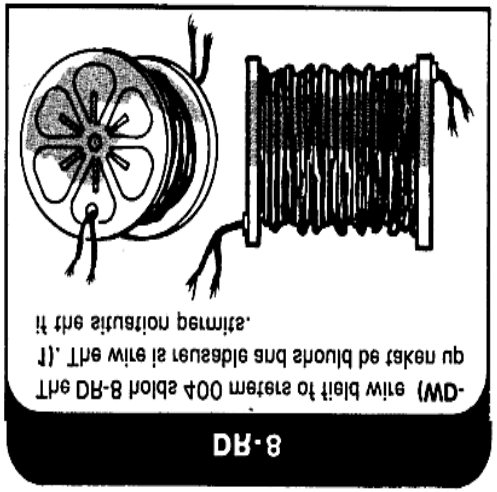


Figure 4-11. M2 compass, observer's view



EQUIPMENT

Curvature template – used to measured the curvature of the fragment to determ the caliber of the shell.

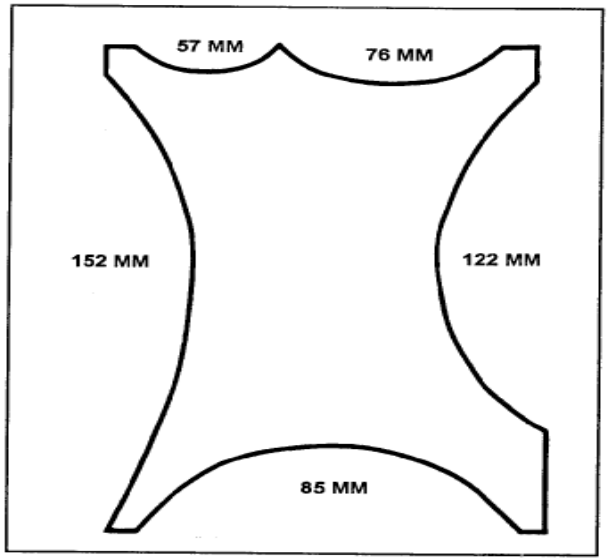


Figure J-1. **Curvature template**

The template may be constructed of heavy cardboard, acetate, wood or other appropriate material. Defense Intelligence Agency Projectile Fragment Identification Guide used to measure fragment dimensions. (DST-1160G-029-85)

SHELL CRATER ANALYSIS

DIRECTION

a. Projectile flight direction can be determined accurately from its crater ricochet furrow. By accurately locating the crater and determining the direction of flight, it is possible to obtain the azimuth of a ray that passes through the enemy position.

While it is possible to determine the direction to a battery from one crater or ricochet furrow, more accurate battery location can be determined by plotting the intersection of the average azimuths from at least three widely separated groups of craters.

SHELL CRATER ANALYSIS

b. Crater analysis, differences in angle of fall, projectile burst patterns, directions of flight, and time fuze settings will help to distinguish between separate enemy batteries firing on a given area.

VALUE OF ANALYSIS

By analyzing shell craters, it is possible to do the following:

a. Verify a suspected artillery location that has been obtained by other means.

b. Confirm the presence of enemy artillery and obtain an approximate direction to it.

SHELL CRATER ANALYSIS

INSPECTION OF SHELLED AREAS

C. Shelled areas are inspected as soon as possible.

*Craters that are exposed to the elements or are abused by personnel deteriorate rapidly thereby losing their value as a source of information.

SURVEY OF CRATER LOCATION

D. Areas must be located accurately enough for plotting on charts, maps or aerial photographs. Deliberate survey is not essential; hasty survey techniques or map spotting usually will suffice. Direction can be determined by use of an aiming circle or a compass.

SHELL CRATER ANALYSIS

1. Pattern. A clear pattern produced on the ground by the detonating shell indicates the direction from which the shell came.

2. Factors Affecting Pattern. Because of terrain irregularities and soil conditions, typical shell crater patterns are the exception, not the rule. Side spray marks are a principle part of a pattern caused by fragmentation. There is much less effect from nose spray. Base spray is negligible from gun and howitzer projectiles but is appreciable from mortars. The width, angle, and density of the side spray pattern vary with the projectile, the angle of impact, the type of fuze, terminal velocity of the projectile, and soil

SHELL CRATER ANALYSIS

DIRECTION

In determining direction, the following are considered:

The effect of stones, vegetation, stumps and roots in the path of the projectile.

Variations in density and type of soil.

The slope of the terrain at the point of impact

From any group, only the most clearly defined and typical

DIRECTION

3. Marks on Vegetation and other Objects. The direction from which a round was fired is often indicated by the marks made as it passes through trees, snow, and walls. The possible deflection of the shell upon impact with these objects must be considered. Evidence of such deflection should not be overlooked.

4. Drifts and Wind Effects. Drift and lateral wind effects do not materially change the direction of the axis of the shell during flight.

5. Ricochet Furrows. Often when an artillery round with a delay fuze is fired at low angle it bounces or ricochets from the surface of the

CRATER ANALYSIS

The first step in crater analysis is to locate a usable crater for determining the direction to the hostile weapon.

The crater should be clearly defined on the ground and should be reasonably fresh.

Since the crater is the beginning point for plotting the direction to the enemy weapon, the grid coordinates of the crater should be determined as an eight-digit grid or as precisely as time and method used will allow.

CRATER ANALYSIS

The direction to the firing weapon must be determined by one of the METHODS described on the following slides.

Shell fragments and fuzes must be collected for use in identifying the type, caliber, and country that manufactured the weapon and/or projectile.

LOW-ANGLE FUZE QUICK CRATERS (ARTILLERY)

The detonation of a projectile causes an inner crater. The burst and momentum of the shell carries the effect forward and to the sides, forming an arrow which points to the rear (toward the weapon from which the round was fired).

The fuze continue along the line of flight, creating a fuze furrow.

There are two methods of obtaining direction to a hostile weapon from this type;

1. **The average of several directions obtained from separate craters.**
2. **The best results are obtained by determining a**

LOW-ANGLE FUZE QUICK CRATERS (ARTILLERY)

FUZE FURROW AND CENTER OF CRATER METHOD

In this method, stakes are placed in the center of a crater and in the fuze furrow.

Then the direction is measured to the hostile weapon. A variation of this method is to place a stake where the shell entered the ground instead of the fuze furrow and determine the direction in the same manner.

This method is rarely possible, how-ever, since indications of the point of entry are usually destroyed by the explosion of the shell.

FUZE FURROW AND CENTER OF CRATER METHOD

1. Place a stake in the center of the crater.

2. Place a second stake in the fuze furrow at the point where the fuze was blown forward to the front of the crater.

3. Setup direction-measu instrument in line with tl stakes and away from fragments.

4. Orient the instrument.

5. Measure the direction the hostile weapon.

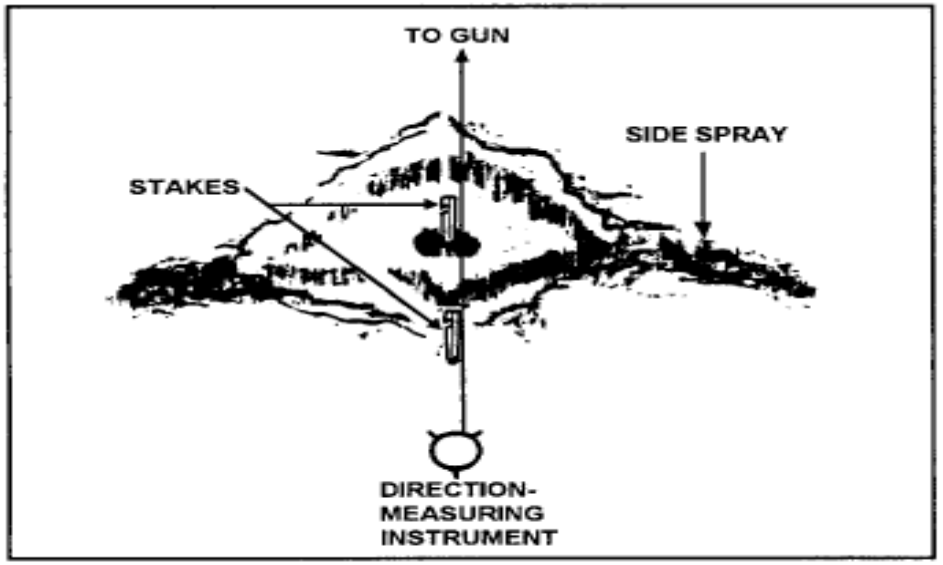


Figure J-2. **Fuze furrow and center-of-crater method**

SEE FIGURE J-2 FM 6-

LOW-ANGLE FUZE QUICK CRATERS (ARTILLERY)

Side-Spray Method. Another method to measure the direction to a hostile weapon is to bisect the angle formed by the lines of side spray. The seven steps in the side sp as follows:

1. Place a stake in the center of crater.

2. Place two stakes, one at the e each line of side spray, equidista from the center stake.

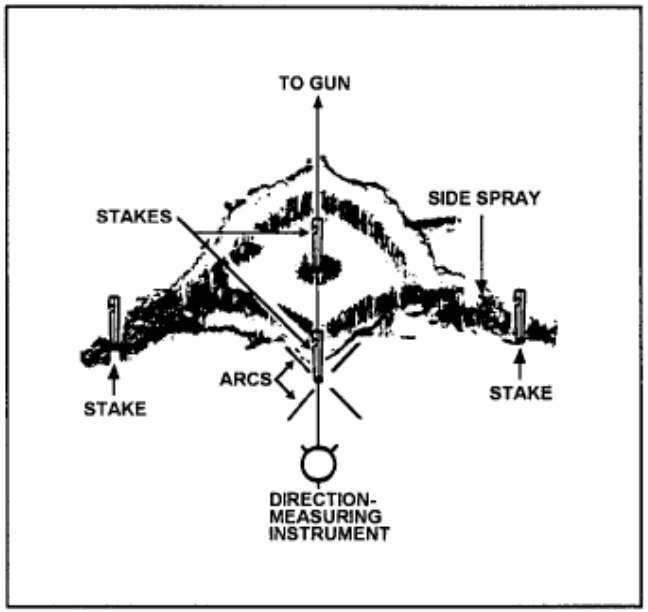


Figure J-3. **Side-spray method**

3. Hold a length of communications wire or another appropriate field-expedient means to each side-spray stake, and strike an

LOW-ANGLE FUZE QUICK CRATERS (ARTILLERY)

4. Place a stake where these arcs intersect.

5. Set up a direction measuring instrument in line with the center stake and the sta the arcs.

6. Orient the instrumen

7. Measure the directio the firing weapon.

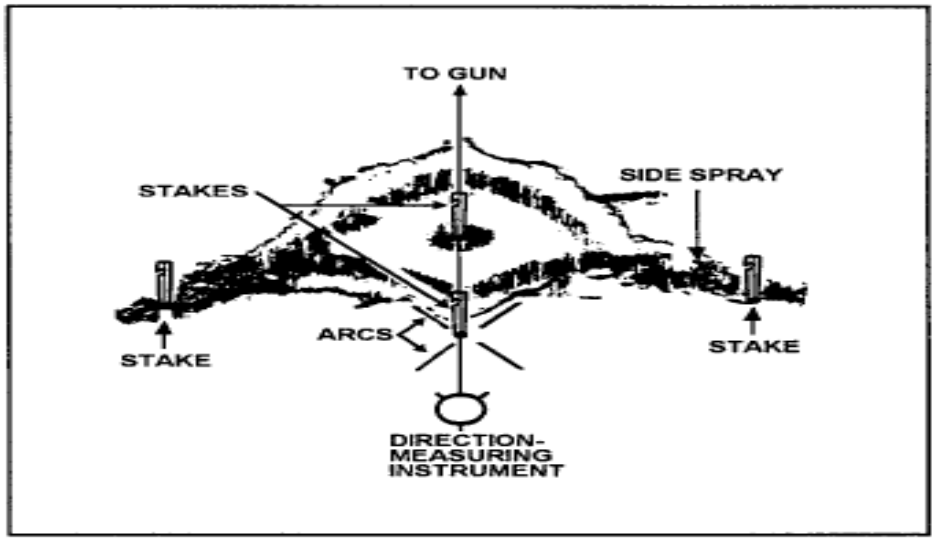


Figure J-3. **Side-spray method**

LOW-ANGLE FUZE DELAY CRATERS (ARTILLERY)

RICOCHET AND MINE ACTION CRATERS

The two types of fuze delay craters are;

Ricochet. The projectile enters the ground in line following the trajectory and continues in a straight line for a few feet, causing a ricochet furrow.

The projectile normally deflects upward and, at the same time, it changes direction usually to the right as the result of the spin, or rotation, of the projectile.

The effect of an airburst can be noted on the ground. Directions obtained from ricochet craters are considered to be the most reliable.

LOW-ANGLE FUZE DELAY CRATERS (ARTILLERY)

The Five steps to determine direction from a ricochet furrow are;

1. Clean out the furrow.

2. Place stakes at each end of a usable straight section of the furrow.

3. Set up a direction measuring instrument in line with the stakes and away from fragments.

4. Orient the instrument.

5. Measure the direction to the weapon.

LOW-ANGLE FUZE DELAY CRATERS (ARTILLERY)

B. Mine Action. This occurs when a shell bursts beneath the ground. Occasionally, such a burst will leave a furrow which can be analyzed in the same manner as the ricochet furrow.

A mine action crater which does not have furrow cannot be used to determine the direction to the weapon.

HIGH-ANGLE SHELL CRATERS (MORTARS)

In a typical mortar crater, the turf at the **forward edge** (the direction away from the hostile mortar) is undercut.

The **rear edge** of the crater is shorn of vegetation and grooved by splinters.

When fresh, the crater is covered with loose earth, which must be carefully removed to disclose the firm, burnt inner crater.

The ground surrounding the crater is streaked by splinter grooves that radiate from the point of detonation.

The ends of the splinter grooves on the rearward side are on an approximately straight line. This line is

HIGH-ANGLE SHELL CRATERS (MORTARS)

A fuze tunnel is caused by the fuze burying itself at the bottom of the inner crater in front of the point of detonation.

Three methods may be used to determine direction from a mortar shell crater;

The Main Axis Method

The Splinter Groove Method

The Fuze Tunnel Method

HIGH-ANGLE SHELL CRATERS (MORTARS)

A. Main Axis Method

The four steps to determine direction by the main axis method areas follows:

1. Lay a stake along the main axis of the crater into symmetrical halves. The stake points in the direction of the mortar.

2. Set up a direction-measuring instrument in line with the stake and away from fragments.

HIGH-ANGLE SHELL CRATERS (MORTARS)

B. SPLINTER GROOVE METHOD

The Five steps to determine direction by the splinter groove method.

1. Lay a stake along the ends of the splinter grooves that extend from the crater.

2. Lay a second stake perpendicular to the first stake through the axis of the fuze tunnel.

3. Set up a direction measuring instrument in line with the second stake and away from fragments.

4. Orient the instrument.

HIGH-ANGLE SHELL CRATERS (MORTARS)

C. FUZE TUNNEL METHOD

The four steps to determine direction by the fuze tunnel method are as follows:

1. Place a stake in fuze tunnel

2. Set up a direction measuring instrument in line with the stake and away from fragments.

3. Orient the instrument.

4. Measure the direction to the weapon.

HIGH-ANGLE SHELL CRATERS (MORTARS)

Note: If the angle of fall is too great (90º angle), the fuze tunnel method cannot be used.

Note: With the exception of the rotating bands and band seats or the tail fins, different types of shells may be identical in one dimension (such as wall thickness) but seldom will be alike in two or more dimensions. Therefore, it is necessary to obtain two or more measurements to make a positive identification.

ROCKET CRATERS

A crater resulting from a rocket impacting with a low or medium angle of fall is analyzed in the same manner as an artillery crater resulting from a projectile armed with fuze quick.

However, if the rocket impacts with a high angle of fall, the crater is analyzed in the same manner as a crater resulting from a mortar round.

The tail fins, rocket motor, body, and other parts of the rocket, may be used to determine the caliber and type of rocket

SHELL FRAGMENT ANALYSIS

A weapon may be identified as to type and caliber from shell fragments found in the shell crater.

Dimensions of the parts as well as of the complete shell, vary according to the caliber and type of shell.

SHELL FRAGMENT ANALYSIS

A. Duds and Low-Order Bursts

The most logical means of identifying the caliber of a projectile is to inspect a dud of that caliber. However, since a dud may not always be available (or, if available, may be too dangerous to handle), a low-order burst is the next best means of identification.

When the explosive filler is incompletely detonated, a low-order burst occurs and large shell fragments result. Such large pieces can be used to identify thread count, curvature, wall thickness, and other information not obtainable on smaller fragments.

SHELL FRAGMENT ANALYSIS

B. High-Order Burst

A high-order burst normally results in small, deformed fragments. These fragments are useless for identification purposes unless they include a section of either the rotating band or the rotating band seat.

Fragments of either of these sections positively identify the shell, since each shell has its own distinctive rotating band markings.

SHELL FRAGMENT ANALYSIS

C. Rotating Bands and Band Seats

A shell may be identified as to caliber, type, and nation of origin from the following:

- **PATTERN OR RIFLING IMPRINTS.**

- **WIDTH, NUMBER, AND SIZE OF ROTATING BANDS.**

- **DIMENSIONS AND PATTERN OF KEYING OR KNURLING ON THE BAND SEATS.**

SHELL FRAGMENT ANALYSIS

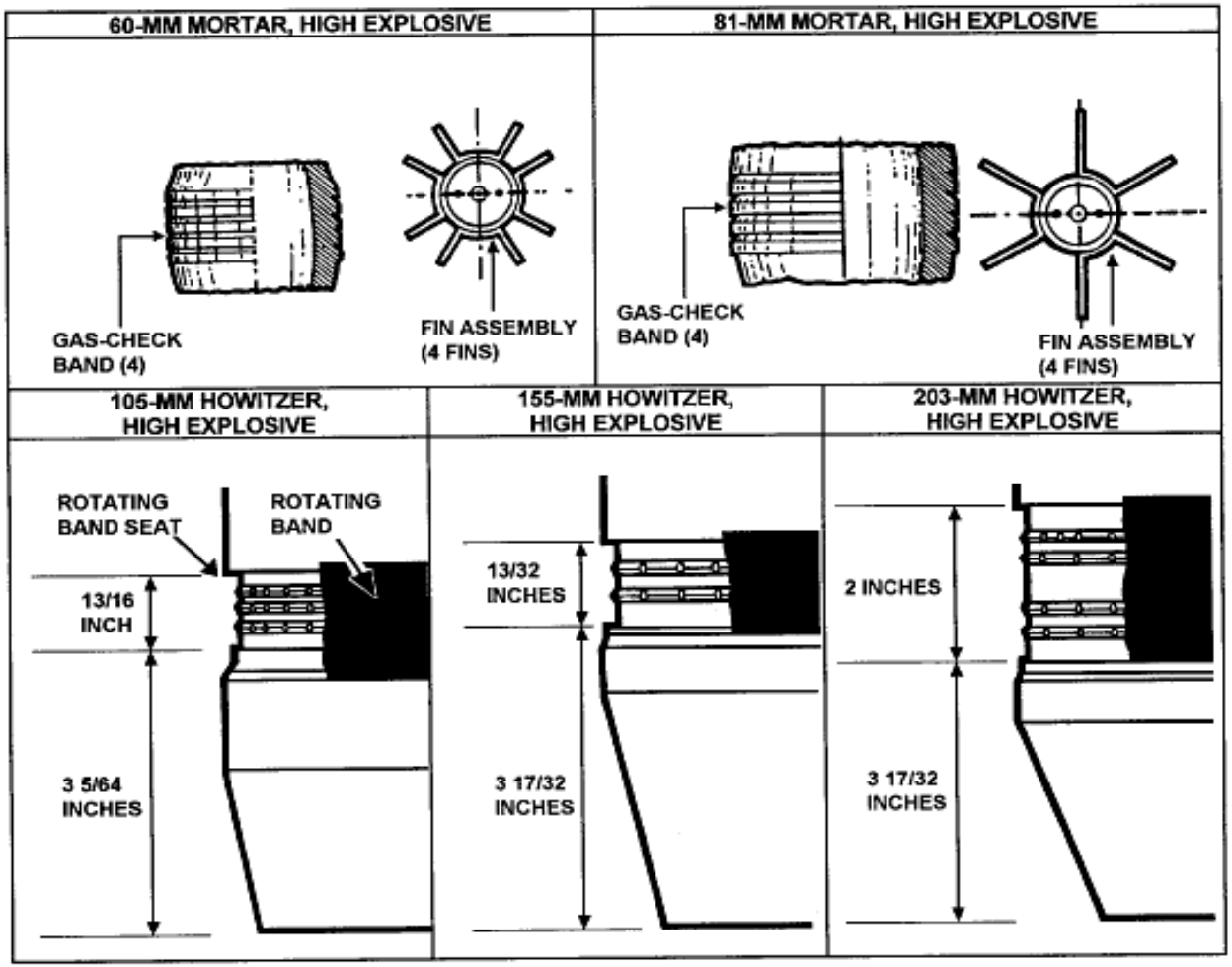


Figure J-9. **Shell fragment and tail identification, US ammunition**

Note: Spin-stabilized artillery projectiles require a rotating band and

SHELL FRAGMENT ANALYSIS

D. Tail Fins **A mortar may be identified from the tail fins.**

Often, these are found in the fuze tunnel of the cra

A mortar that is fin-stabilized ma be identified fror the pieces of the projectile on whi the rifling is Imprinted.

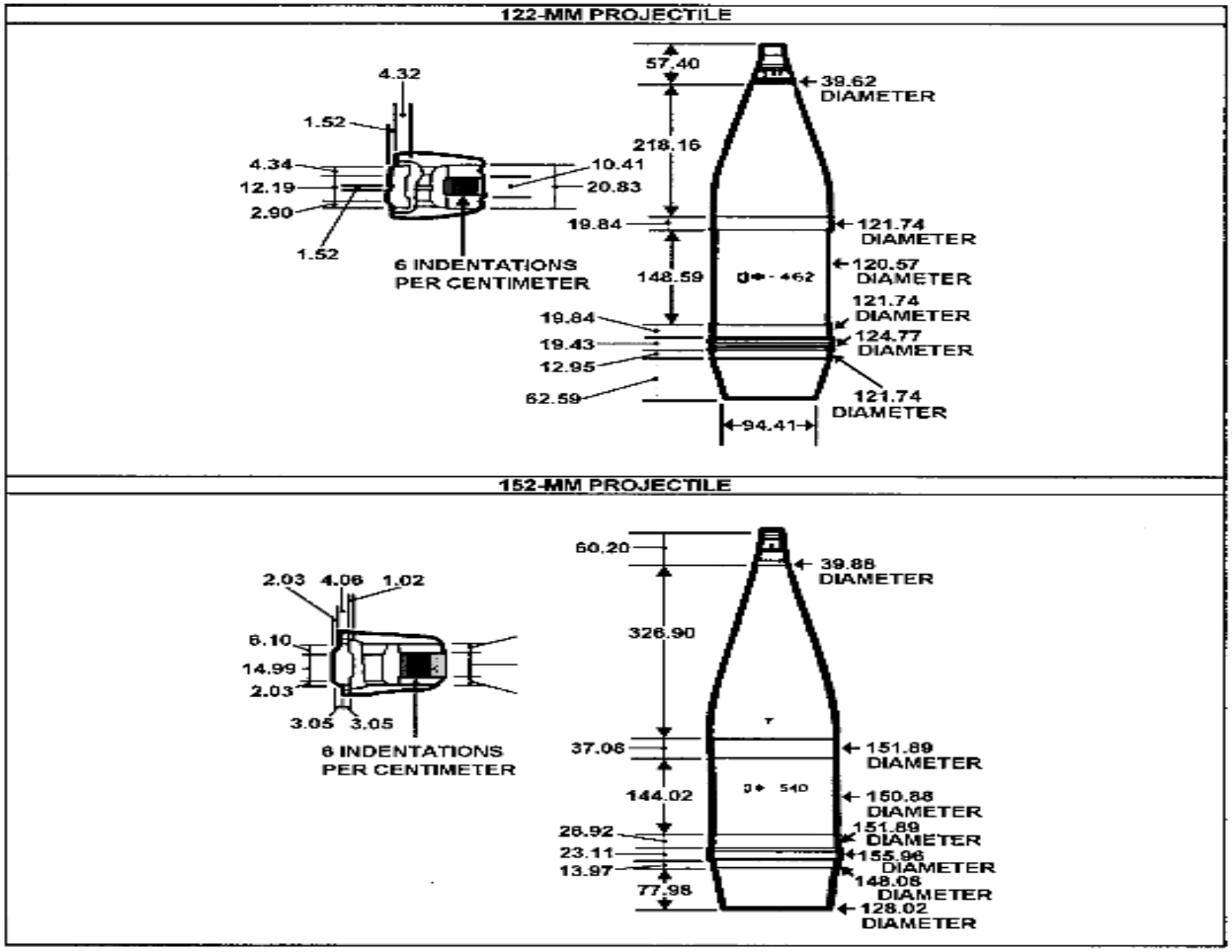


Figure J-10. **Other nations' ammunition (continued)**

SHELL FRAGMENT ANALYSIS

E. Fuzes

Since the same type of fuze may be used with several different calibers or types of projectiles, it is impossible to establish the type and caliber of a weapon by this means.

SHELLING REPORTS

The Division Artillery (DivArty) is responsible for counterfire. Therefore, all reports should be sent to the DivArty Tactical Operations Center (TOC) through either fire direction or fire support channels.

SHELLING REPORTS

If a report is received by a DS battalion and that battalion decides to attack, the report of action taken and a damage assessment, if available, should be forwarded to the DivArty TOC when the action is completed.

A. Contents. To provide a standard method of rendering reports on enemy bombing, shelling, and mortaring within the United States and NATO armed forces refer to STANAG 2103 as implemented in FM 3-100 (in conjunction with STANAG 2008), for guidance in reporting the type of attack.

SHELLING REPORTS

b. Artillery Counterfire Information Form. The information obtained from a crater should be forwarded by the most rapid means available the ATI;SHR followed up with DA FORM 2185-R (Artillery Counter Fire Information(ACIF)).

Regardless of how little information has been obtained, do not hesitate to forward it. Fragmentary or incomplete information (a radio or telephone report) is often valuable in supplementing or confirming existing information. This radio or telephone report may be followed by a written report (DA FORM 2185-R).

SHELLING REPORTS

ARTILLERY COUNTERFIRE INFORMATION

(For use of this form, see FM 6-121; the proponent agency is TRADOC.)

RECEIVED BY	FROM	TIME	NUMBER

SECTION I - BOMREP, SHELREP, MORTREP, OR ROCKREP (Cross out items not applicable.)

UNIT OF ORIGIN (Current call sign address group or code name)	POSITION OF OBSERVER (Encode if HQ or important OP or if Column F gives info on loction)	DIRECTION (Grid bearing of FLASH, SOUND, or GROOVE of SHELL [state which] in mils unless otherwise stated). (Omit for aircraft)	TIME FROM	TIME TO	AREA BOMBED, SHELLED, OR MORTARED (Grid ref [in clear] or grid bearing to impact in mils and distance from observer in meters [encoded]) (Dimension of the area in meters) by (the radius) or (length and width)	NUMBER AND NATURE OF GUNS (Mortars, rocket launchers, aircraft, or other methods of delivery)	NATURE OF FIRE (Adjustment, fire for effect, or harassing) (May be omitted for aircraft)	NUMBER, TYPE, AND CALIBER (State whether measured or assumed) OF SHELLS, ROCKETS (or MISSILES), AND BOMBS	TIME OF FLASH-TO-BANG (Omit for aircraft)	DAMAGE (Encode if required)
F22	NA	4810 mils	0545	0547	39268415	4 / ARTY	H	8 / HE / 122	NA	NA
A	B	C	D	E	F	G	H	I	J	K

SECTION II - LOCATION REPORT | **SECTION III — COUNTERFIRE ACTION**

REMARKS	SERIAL NUMBER (Each location that is produced by a locating unit is given a serial number)	TARGET NUMBER (If the weapon or activity has previously been given a target number, it will be entered here)	POSITION OF TARGET (The grid reference or grid bearing and distance of the located weapon or activity)	ACCURACY (The accuracy to which the weapon was located. CEP in meters and the means of location if possible)	TIME OF LOCATION (Actual time the location was made)	TARGET DESCRIPTION (Dimensions if possible): 1. Radius of target 2. Target length and width in meters	TIME FIRED (Against hostile target)	FIRED BY	NUMBER OF ROUNDS, TYPE OF FUZE, AND PROJECTILES
L	M	N	P	Q	R	S	T	U	V

DA FORM 2185-R, 1 APR 90 (Conforms with STANAG 2008) Edition of 1 May 78 is obsolete.

Figure J-11. Completed DA Form 2185-R

Note: A reproducible copy of DA FORM 2185-R is located in the back of FM 6-50

SHELLING REPORTS

C. Fragments. Any usable fragments obtained from crater analysis should be tagged (shoe tag) and sent to the battalion S2. As a minimum, the tag should indicate the following:

1. **The location of the hostile weapon.**

2. **The direction to the hostile weapon.**

3. **The date/time group of the shelling**

4. **Mortar, artillery, or rocket, if known.**

SHELLING REPORTS

EXAMPLE

The information in the following situation is illustrated on the completed DA FORM 2185-R. You are the executive officer of Battery A, 1st Battalion, 3d Field Artillery. Your call sign is A3F22, which is located at grid 39288415. At 0545 hours, the enemy shelled your position for 2 minutes with a total of eight rounds of HE. The tempo and pattern of bursts suggest an enemy four gun battery. Your battery commander believes that the enemy's intent was harassment. Your SHELREP team determined the direction to the enemy battery to be 4,810 mils. They also located a fragment which included a portion of the rotating band seat. The shell has been identified as an enemy 122-mm howitzer projectile.

SHELLING REPORTS

EXAMPLE

The four blanks above SECTION I of DA FORM 2185-R are not completed by the SHELLREP team. They are filled in by the receiving agency, for example, the battalion S2 section.

- Items B and K of SECTION I are encoded for security reasons.
- The current call sign or code name for the unit is used in Item A.
- Item B is not applicable when this form is used for Crater analysis.
- SECTIONS II and III are completed by the target production section of the DivArty TOC.

SHELLING REPORTS

EXAMPLE

The information contained in a SHELLREP is forwarded by the DS artillery S2 to the targeting cell at DivArty.

The S2 plots (on a SHELREP overlay) the location of the crater and a line representing the direction measured to the weapon. He compares the information with that received from other sources and attempts to locate enemy weapons from the intersections of direction lines to weapons of the same caliber.

SUMMARY

- PURPOSE
- REFERENCES
- WHAT IS CRATER ANALYSIS
- TEAM & EQUIPMENT
- DETERMINE DIRECTION
- SHELL REPORTS

QUESTIONS

?